Amino Acids

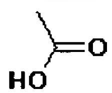
An **AMINO ACID** is by definition an organic compound containing an amine group $-NH_2$ and a carboxylic **acid** group  in the same molecule. While there are many forms of **amino** acids, all of the important **amino** acids found in living organisms are **alpha-amino** acids. **Alpha amino** acids have the -COOH and -NH_2 groups both attached to the same carbon atom, called the **alpha** carbon atom. The simplest **amino acid**, which is the molecule glycine, H_2NCH_2COOH, contains no asymmetric carbon atoms (tetrahedral carbon atoms with four different groups attached). All of the other **amino** acids do contain such a carbon atom and are therefore optically active. The general structure of the **alpha-amino** acids is R-$CHNH_2$(**alpha**)-COOH, and optical activity for the **alpha-amino** acids more complex than glycine is found at the **alpha** carbon. The **amino** acids which have been found to be incorporated into the proteins of living organisms are listed in the Table below.

Table: Amino Acids Found to Be Incorporated Into Proteins

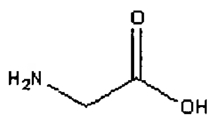
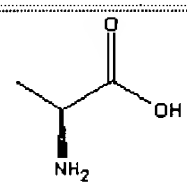
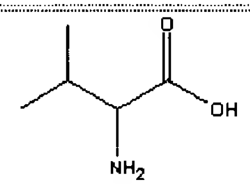
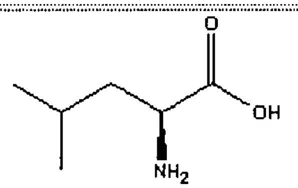
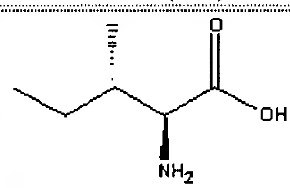
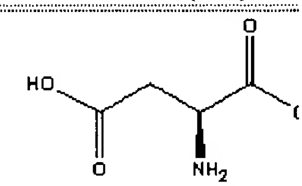
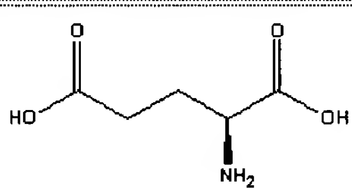
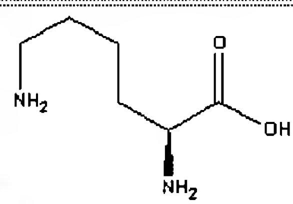
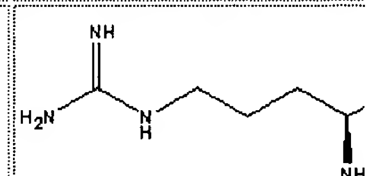
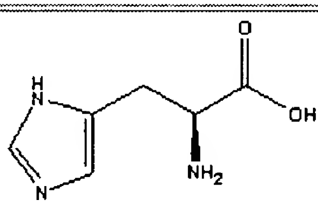
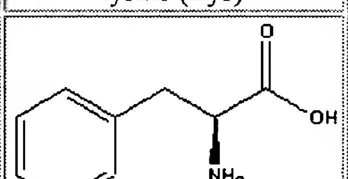
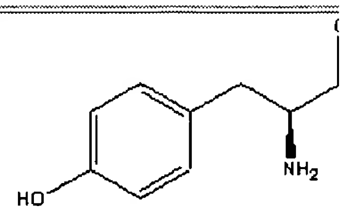
Name (Abb.)	R Group	Class	Synthesis
glycine (Gly)	H-	hydrocarbon	yes
alanine (Ala)	CH3-	hydrocarbon	yes
valine (Val)	(CH3)2CH-	hydrocarbon	no
leucine (Leu)	(CH3)2CH2CH2-	hydrocarbon	no
isoleucine (Ile)	CH3CH2CH(CH3)-	hydrocarbon	no
aspartic **acid** (Asp)	HOOCCH2-	acidic	yes
glutamic **acid** (Glu)	HOOCCH2CH2-	acidic	yes
lysine (Lys)	H2N(CH2)4-	basic	no
arginine (Arg)	HN=C(NH2)NH(CH2)3-	basic	no
histidine* (His)	ring structure	basic	no
phenylalanine (Phe)	C6H5CH2-	aromatic	no
tyrosine* (Tyr)	HOC6H5CH2-	aromatic	yes
tryptophan* (Trp)	ring structure	aromatic	no
serine (Ser)	HOCH2-	alcohol	yes
threonine (Thr)	HOCH(CH3)-	alcohol	no
methionine (Met)	H3CSCH2CH2-	sulfur	no
cysteine (Cys)	HSCH2-	sulfur	no
asparagine (Asp)	H2NCOCH2-	amide	yes

glutamine (Gln)	H2NCOCH2CH2-	amide	yes
proline* (Pro)	heterocyclic ring	unique	yes

Note: the hydroxyl group is para on the ring in tyrosine.

AMINO ACIDS have both an acidic group, in the carboxylic acid, and a basic group, in the amine. Under physiological aqueous conditions a proton transfer from the acid to the base occurs, forming a dipolar ion or zwitterion, because the carboxylic acid is a much stronger acid than is the ammonium ion. The actual structure of glycine in solution, for example, is $^{+}H_3NCH_2COO^{-}$ at pH 7 rather than H_2NCH_2COOH. At very low pH the acid group can be protonated and at very high pH the ammonium group can be deprotonated, but the forms of amino acids relevant to living organisms are the zwitterions.

Each asymmetric carbon gives rise to two optical isomers which are traditionally distinguished by the letters D or L. Only those amino acids which are the L forms (left-handed) at the alpha carbon are found in terrestrial life.

 glycine (Gly)	 alanine (Ala)	 valine (Val)
 leucine (Leu)	 isoleucine (Ile)	 aspartic acid (Asp)
 glutamic acid (Glu)	 lysine (Lys)	 arginine (Arg)
 histidine* (His)	 phenylalanine (Phe)	 tyrosine* (Tyr)